GOVERNMENT OF INDIA.

INDIAN MUNITIONS BOARD

Report on Portland Cement of Indian Manufacture

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MR. HENRY A. F. MUSGRAVE,

Superintendent of Local Manufactures and Government Test House, Alipor Calcutta.

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THE extent to which Portland Cement is required for Public Works and construction work generally in India is shown by the Imports which, for the three years prior to the War, 1912-14, averaged about 3,000,000 cwts. per annum, of which 84 per cent. came from the United Kingdom and the balance from Germany, Belgium, Italy, Austria and Hong Kong Until 1914 the manufacture of cement under up-to-date conditions had not been started in India, although a small amount of cement of fair quality was being made for local use in one or two places, but within the past three years a few firms have installed modern plant and started manufacturing cement by scientific methods. Users are naturally prone to look askance at a new product of Indian Manufacture and often preferred to purchase well-known brands of British-made cement even though [illegible] War conditions have rendered [illegible] and have not only given an im[illegible] naturally attracted to the market Japanese and other brands of various grades and qualities.

This report deals with the manufacture of three principal brands of Indian Cement which are :—

(1) Bundi "B.B.B." Portland Cement manufactured by the Bundi [illegible] Limited, Lakheri (Manag- [illegible] Company, Bombay ;

(2) [illegible] t and Industrial Company, [illegible] Messrs C. Macdonald and Company, Bombay) ; and

(3) Porbandar "Ganapati Brand" The Indian Cement Company Limited (Managing Agents, Messrs. Tata, Sons and Company, Bombay),

all of whom manufacture a high grade cement under modern scientific conditions.

Cement may be defined as a compound consisting chiefly of silicates and aluminates of lime produced by the calcination to incipient vitrification of a mechanical mixture of chalk and clay or any other material which contains the same calcareous and argillaceous materials in suitable proportions. Whatever the method employed may be, three distinct operations are necessary, and the object of each particular process is to perform these operations on the particular raw material at hand as efficiently and cheaply as possible. These operations are :—

(1) Intimate admixture of the raw materials. (2) Conversion of the raw material by calcination into the necessary chemical compounds. (3) Reduction of the burnt product to a fine powder to enable it to set and harden in the presence of water.

Intimate admixture of the raw materials is necessary to enable the chemical combination during burning to be as complete and uniform as possible. To ensure this it is necessary to pulverise them so that 80 per cent. to 90 per

cent. will pass through a sieve containing 32,400 holes to the square inch (180×180 mesh). The presence of coarse particles in the raw meal or slurry leads to unsoundness in the finished cement if normally burnt, or necessitates overburning to enable the coarse particles to combine, causing a weakened cement as a result of the excessive calcination. Where the raw materials are soft marl, chalk, or clay, comminution can be done at a much lower cost than in factories where hard limestone either pure or of the argillaceous variety is used. Little imagination is required to realise that the reduction of what are practically boulders of rock to an impalpable powder necessitates the use of considerable power and causes expense in wear and tear to the grinding machinery employed.

The three brands mentioned above are all made from hard raw materials, and reduction in each case is made in stages. The first reduction is made in crushers of the jaw type which break up the stones into pieces which will pass through a ring of 2½" diameter. The second reduction is made in a kominor or ball mill which is a cylindrical drum containing several tons of hard steel balls which, when the drum is rotated, crush the stones by impact reducing them to the texture of coarse sand. By a sieving device inside the ball mill particles sufficiently ground are passed out of the mill and the balance is returned to the body of the mill for further treatment. The final reduction takes place in a tube mill consisting of a long rotating cylinder containing ovoid flint pebbles or special shaped pieces of steel. In this mill the material is ground to powder by the attrition of the pebbles or steel "nibs." The treatment of the calcined product or clinker after it leaves the kiln is precisely similar except of course that preliminary crushing in a Jaw Crusher is not required for rotary kiln clinker.

The percentage of lime has an important bearing on the strength of the cement Speaking generally the higher the lime content the stronger will the resulting cement be. On the other hand "free" lime, *viz.*, lime uncombined with silica or alumina, causes "unsoundness" and it therefore follows that with raw materials ground small, intimately mixed and well calcined, a larger proportion of lime can be allowed with safety and the strength of the cement will be greater. Formerly calcination was carried out in intermittent vertical "Chamber" kilns, but these have been almost superseded by the inclined rotary kiln which permits of more complete control of the temperature of calcination than is possible with the intermittent kiln and burns the raw materials more completely and uniformly. Rotary kilns are in use at both Katni and Bundi. Continuous kilns of the vertical type are in use at Porbandar and offer certain advantages. In Kilns of the Chamber type dried "Raw Meal" is fed into the kiln with layers of coke between. The ash from the coke appears in the finished product raising the proportion of silica and alumina appreciably. This is compensated for in proportioning the ingredients of the raw meal, a higher percentage of calcium carbonate being allowed. Sulphur from the coke also appears as sulphuric anhydride in the cement and acts in a similar manner to the gypsum which is added to rotary kiln cements after calcination. In the old chamber kilns the ash did not penetrate to the interior of the clinker and the product was irregular. This defect is remedied to a great extent in the Trachsler Patent Kiln in use at Porbandar by incorporating a certain amount of ground coke with the Raw Meal briquettes. A more uniformly burnt clinker also results from the use of this patent kiln than is possible with the ordinary vertical kiln In the Rotary Kiln the raw material, whether it be wet in the form of slurry or dry as "Raw Meal," is fed direct into the upper end of a long inclined rotating cylinder, through which it slowly progresses, continually increasing in temperature until it reaches the calcining zone at the other end of the kiln, the temperature at this end being maintained by a burner using coal dust oil fuel, or occasionally producer gas. The first named is used at both the Katni and Bundi Works. The products of combustion pass through the kiln and out at the upper end. The clinker after calcination falls into a cooler through which the air necessary for combustion of the fuel passes on its way to the kiln In this way the clinker is cooled and the whole system is not only continuous, systematic, and easily controllable but to a certain extent regenerative. A large proportion of the products of combustion pass away, and such portion as remains is incorporated uniformly in the finished product.

Both the Wet and Dry Processes are in use, the former at Katni and the latter at Bundi and Porbandar. Opinions differ as to the advantages of the two systems and much depends on the raw materials used and the machinery employed. The Wet Process, in which the mechanical mixture of calcium carbonate, silica and alumina, etc., is in the form of a slip or slurry, permits of a very complete and intimate mixture of the constituents. The tanks or silos of slurry are kept in a constant state of motion by mechanical stirrers and any additions which may be made to correct deficiencies before the slurry is passed to the kiln are dispersed uniformly throughout the mass. The consumption of fuel in the kiln is of course higher because the water which is usually about 40 per cent of the whole has to be driven off before chemical union can take place. Another advantage of the Wet Process is the added ease of conveying wet slurry from one machine to another. Where the composition of the raw material is at all variable the Wet Process is greatly to be preferred.

The tests which appear in this report were made rigidly in accordance with the methods laid down by the British Engineering Standards Committee (1915 Report) with the exception that whereas the British Standards Specification demands that the temperature during the tests shall be between 58° and 64° F. these tests were made between 80° and 90°F., an average of about 30°F. higher. This being the case, a little intelligent interpretation is required. Although the effects of higher temperature are known, the precise amount of these variations has not been fully investigated. It is neither desirable nor feasible in general to carry out tests in India at other than ordinary shade temperatures and there is, therefore, a need for a Standard Specification for this country which, while following the lines of the British Standards Specification, shall be modified to suit the altered conditions obtaining here. It is hoped that soon after the war comparative tests may be made with a view to drawing up such a specification.

The principal variations are in the setting time and the tensile strength. The setting and hardening of cement, involving as it does chemical action, is accelerated by heat. Hence the samples tested show a quicker set than would have been the case had the tests been made at 58°—64° F. In the tensile strength the effect of heat is not necessarily to make the cement pass the specification easier. Increase of strength takes place more rapidly at first, and therefore, although the results at 7 days will be higher, the strength at 28 days demanded by the specification will also be higher. For example, supposing a sample tested at 60°F. attained a strength of 600 lbs. at 7 days and 700 lbs. at 28 days (margin over required increase 33 lbs). If tested at 90° F it might attain strengths of 637 lbs and 705 lbs. respectively showing a margin of increase at 28 days of only 5 lbs over that required by the specification and the sample would appear to be of lower quality than it really is. I am inclined to the belief that the effect of increase temperature at the time of test is to favour the sample slightly in regard to the sand-cement tests and to make the neat-cement tests appear a little less favourable to the sample.

The Bundi Hydraulic Lime and Cement Company's Works, Lakheri, Rajputana.

The works are situated at Lakheri in Bundi State, Rajputana, on the Bombay, Baroda and Central India Railway, 250 miles south of Delhi on the Nagda-Muttra Section. The Company's lease covers an area of 101 square miles. The suitability of the limestone deposits at Lakheri for making Portland Cement was accidentally discovered at the time the Nagda-Muttra Section of the Bombay, Baroda and Central India Railway was under construction. The stone had been long used for lime-burning and it was found to have hydraulic properties similar to those of the Blue Lias formations in England. The district was prospected and the present company resulted. Pending the installation of a Rotary Kiln Plant the attention of the company was devoted to the production of hydraulic lime, principally to meet the requirements of Imperial City engineers at Delhi, and later Portland Cement on a small scale burnt in vertical kilns was manufactured. The present plant was started up in September 1916, ...

works are situated amidst hilly country about 3 miles from Lakheri Station at an elevation of about 750 feet above sea level and are connected with the Bombay, Baroda and Central India Railway by a narrow gauge light railway.

Staff and Labour.

The staff includes the Manager, a Chemist, an Engineer, and Burners, all of whom are Europeans experienced in cement manufacture, and office assistants, the latter being Indian clerks chiefly obtained from Bombay and Madras Presidencies.

Raw Material.

Limestone.—There exist large quantities of argillaceous limestone and semi-pure limestone containing various percentages of calcium carbonate. These varieties of limestone are blended together to give the correct proportions of lime, silica and alumina. The extent of these deposits is enormous, the out-crop extending for several miles along the foot of the hills adjacent to the Works. The quarries which are being worked at the present time are situated about ¾ mile from the Works. The limestones are hard and free from impurities and none of the quarried material needs to be discarded. The initial mixing of the stone takes place in the quarry and the final adjustment is made in the raw mill according to tests conducted at each stage of the process.

Gypsum.— Gypsum is imported from Jodhpur and Rerwar, and a small quantity is added to the clinker during the process of grinding to correct setting time.

Clay — Clay does not exist except in very small quantities and is not used or needed in the manufacture of this cement, argillaceous material being present in the limestone in the requisite proportions.

Coal.— The coal used is from the Bengal coal-fields and other selected mines.

Description of Plant and Process of Manufacture.

The cement is manufactured by the "Dry Process." The plant consists of a raw mill, rotary kiln, coal mill, cement grinding mill, power plant, and cement store. The machinery and plant used is thoroughly up-to-date and of recent design. The quarried stone, after leaving the quarry, is conveyed in tip wagons holding 25 c. ft. each to the raw mill. Any surplus stone quarried is conveyed to a dump or store which provides a supply of average stone of all grades for use during the periods of shortage of labour. At the raw mill the stone is dumped into a jaw crusher having a capacity of 7 tons per hour, from which it passes by an elevator to a reinforced concrete hopper.

This hopper feeds 2 large kominors or ball mills, containing 5 tons of steel balls each, in which the crushed stone is coarsely ground. The coarse ground material is elevated and distributed for storage and mixing into three large silos.

At this stage the material is tested every hour for the calcium carbonate ($Ca\ Co^3$) content, any necessary adjustments being made by the introduction of high-limed or low-limed stone as the case may be into the crusher. Provided the average of a series of tests on the material gives the correct percentage of $Ca\ Co_3$ the distribution and mix in the silos brings the whole material to the average percentage of $Ca\ Co_3$.

The rough ground material is then conveyed and fed into a tube mill which reduces the material by attrition to the necessary fineness of division.

Analysis of raw meal—	Per cent.
Loss on ignition	34·2
Silica	16·7
Iron oxide	0·9
Alumina	2·8
Lime	43·5
Magnesia	1·3
Total	99·4

After passing through the tube mill the raw meal is fed into another series of three silos where a further mixing of the material in a fine state takes place. This finished meal is stored and fed to the kiln when required, and it will be seen that a very complete adjustment of mixture takes place.

The material is conveyed from the raw mill to the rotary kiln by screw conveyors through a measuring machine which regulates the amount of meal fed into the kiln. As the meal is in a dry state it passes through a damping machine from which it drops through a feed pipe into the kiln. The added moisture is about 12 per cent. by weight, and is only necessary to prevent the finely ground material from being drawn up the chimney before it has the opportunity of proceeding down the kiln to the burning zone. The rotary kiln has no special features; it is of the ordinary type of dry rotary kiln 175 feet long and 9 feet diameter.

From the kiln the clinker, which when thoroughly burnt, has a temperature approx. 2800°, passes through a cooler situated directly under the kiln from which it emerges at a temperature of 100°—150° F.

The firing of the kiln is by means of finely ground coal dust which is blown in at the firing end of the kiln The coal is first fed into a roller mill which breaks up any lumps present.

From the roller mill it is elevated and stored and later passed through a drying cylinder where it is dried thoroughly before passing to the tube mill for final grinding. It is essential that the coal should be dry as damp coal causes the mill to clog.

Analysis of clinker—	Per cent
Loss on ignition	·2
Insoluble matter	·4
Silica	25·4
Iron oxide	1·6
Alumina	4.3
Lime	66·7
Magnesia	1·4
Total	100·0

The Cement Mill consists of a ball mill and tube mill with the necessary elevators and conveyors. About $1\frac{1}{2}$ per cent. of gypsum is added during this process to correct setting time. The finished cement passes along a screw elevator to the cement store and bagging shed

F [illegible] packed by hand into bags, which after being filled are w [illegible] t adjusted. The bags hold 188 lbs. e[illegible] of very strong woven jute. A special patent wire fastener is used in tying the neck of the bag which cannot [illegible] without rendering the fastener useless for further use, thus providing [illegible] As a protection against weather [illegible] wagons. Bags are less expensive than casks and unless exposed to rain or subjected to rough handling or long sea voyages are quite suitable for the purpose.

The capacity of the works as at present existing is 26,000 tons of Portland Cement per annum.

Testing and Sampling.—Sampling and tests are carried out at the works at each stage of the manufacture and during the packing of the finished cement.

GOVERNMENT TEST HOUSE.

ALIPORE, CALCUTTA.

REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT, BUNDI CEMENT COMPANY'S WORKS.

Name and Brand of Cement—" B. B. B." Portland Cement.

—	Results obtained.	Standard (1915).
1.—Fineness of Grinding—		
Residue on Mesh, 180 × 180 . .	10·0 per cent	Not more than 14 per cent.
Do. 76 × 76 . .	0·4 "	Ditto 1 "
2.—Specific Gravity	3·17	Not less than 3·10.
3.—Chemical Composition—		
Proportion of lime to Silica and Alumina.	...	Between 2·85 and 2·0.
Insoluble Residue	...	Not more than 1·5 per cent.
Magnesia	...	Ditto 3·0 "
Sulphur calculated as $S.O_3$ . .	...	Ditto 2·75 "
Total loss on Ignition . . .	...	Ditto 3·0 "
4.—Tensile Strength (Neat) . . .		
7 days (average of 6 briquettes) lbs. (= W_n.)	710	Not less than 450 lbs.
28 days (ditto) lbs.	757	Do. $W_n + \frac{40,000}{W_n} = 766$.
5.—Tensile Strength (Cement and Sand)—		
7 days (average of 6 briquettes) lbs. (W_s).	320	Not less than 200 lbs.
28 days (ditto) lbs.	427	Do. $W_s + \frac{10,000}{W_s} = 351$.
6.—Setting Time—		
Initial	130 mins.	Not less than 30 mins.
Final	About 3¼ hrs.	Not more than 7 hrs.
Classification	Slow.	
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould.		
(a) Cement aërated 24 hours .	1½ mm.	Not more than 10 mm.
(b) Do. 7 days test (a) having failed.	...	Do. 5 mm.

Proportion of water used in gauging—
(a) Neat briquettes . . . . 21 per cent.
(b) Cement and Sand briquettes . . . . 8¼ "
Temperature during period of testing . . . . 76°—85°F.

GOVERNMENT TEST HOUSE,

ALIPORE, CALCUTTA.

REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT. BUNDI CEMENT COMPANY'S WORKS

Name and Brand of Cement—"B. B B." Portland Cement.

Nature of Sample—Taken from Storage Bins.

—	Results obtained.	Standard (1915).
1.—Fineness of Grinding—		
Residue on mesh, 180 × 180 .	10·6 per cent.	Not more than 14 per cent.
Ditto 76 × 76 . .	0·1 „ „	Ditto 1 „ „
2.—Specific Gravity	3·19	Not less than 3·10.
3.—Chemical Composition—		
Proportion of lime to silica and alumina.	...	Between 2·85 and 2 0.
Insoluble residue	..	Not more than 1·5 per cent
Magnesia	...	Ditto 3 0 „ „
Sulphur calculated as SO_3 . .	...	Ditto 2 75 „ „
Total loss on ignition . . .	...	Ditto 3·0 „ „
4.—Tensile strength (Neat)—		
7 days (average of 6 briquettes) lbs. ($=W_n$).	696	Not less than 450 lbs.
28 days (average of 6 briquettes) lbs.	759	Ditto $W + \frac{40,000}{W_n} = 753$
5.—Tensile strength (Cement and Sand)—		
7 days (average of 6 briquettes) lbs. (W_s).	402	Ditto 200 lbs
28 days (average of briquettes) lbs. .	512	Ditto $W + \frac{10,000}{W_s} = 427$
6.—Setting Time—		
Initial	110 mins.	Not less than 30 mins
Final	Under 7 hours	Not more than 7 hours
Classification	Slow	Not less than 3 hours.
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould —		
(a) Cement aerated 24 hours . .	0 5 mm	Not more than 10 mm
(b) „ 7 days Test (a) having failed.	. .	Ditto 5 „

Proportion of water used in gauging—

(a) Neat briquettes	20·5 per cent.
(b) Cement and Sand briquettes	8·25 „
Temperature during period of testing	80°—90° F.

Remarks.—Regular monthly samples of this Company's cement have been tested by us over a period of nearly 2 years and have shown that this factory not only produces a cement equal to the best British brands, but what is even more important produces a cement which is very uniform in quality. Tests over the whole period show but little variation in any characteristic. This is a feature of no little importance. No sample has been found to have a quick setting time. The high results recorded for the sand-cement tensile strength call for some comment. Not only are the results for the 7 days tests 100 per cent. higher than the minimum demanded by the specification but the increase of strength at 28 days is 110 lbs. (the minimum increase being 25 lbs.) which is 440 per cent. greater than the minimum required increase.

Taking an average figure for the period during which the present plant has been in operation I find that the tensile strengths are as follows :—

Neat.	B. S. S. Requirements.	Sand and Cement.	B. S. S. Requirements.
7 days = 736	400 lbs.	7 days = 382	200 lbs.
28 days = 793	790 lbs.	28 days = 483	408 lbs.
Increase = 57	54 lbs.	Increase= 101	26 lbs.

Due allowance being made for the higher temperature of testing in India (see general reference to this at the beginning of the report), the effect of which is to hasten maturity and therefore give somewhat higher results for tensile strength the fact remains that the results achieved by this company are exceedingly good. The sand and cement strengths for "B. B. B." Cement have never been exceeded and rarely even approached in tests made by this department of English cement.

The Company have the advantage of excellent and extensive deposits, machinery and organization are thoroughly up to date, and the most careful system of analysis and check is observed at every stage of the process.

THE KATNI CEMENT AND INDUSTRIAL COMPANY'S WORKS, KATNI, CENTRAL PROVINCES.

The works of the Katni Cement and Industrial Company are situated in Tikuri village, which is owned by the Company and occupies a very favourable site lying close to the main East Indian Railway line 2½ miles distant from Katni Junction, where are also branches of the Great Indian Peninsula and Bengal-Nagpur Railways.

The erection of the works and the installation of the plant was completed in October 1914. Manufacture for the market commenced in earnest in 1915 and production has increased and is increasing, rising from 13,000 tons in 1915 to 31,000 tons in 1916. The output this year will be still greater. The cement plant was designed and constructed by Messrs. F L. Smidth of Copenhagen, a Continental firm of repute in the industry, the machinery being driven electrically from energy obtained from Turbo-Generators. The electrical equipment was supplied by Messrs. Siemens Bros. Steam is obtained from three sets of Babcock and Wilcox boilers of 850 H. P. each.

Labour.—Native labour is obtained mainly from the surrounding district and may be taken as fairly constant except at such times when the crops are being harvested and sown. When the quarries are in full operation the Company employs about 2,000 labourers and houses for a large number of them are in course of erection by the Company.

Raw Material.

Water is obtained from a river about half-a-mile from the works. The water is pumped through 18″ diameter pipes into a large storage ferro-concrete reservoir which has a capacity of 1½ million gallons and stands 135 feet above the works. The water is soft and has no corroding action on the boilers.

Limestone.—Large supplies of limestone are to be found in the immediate neighbourhood and surrounding country. The quarries from which the limestone is now being excavated are situated about ¾ mile from the works.

The limestone is broken up by pick and by blasting and carried by coolies to the quarry, loaded into small tip wagons of 15 c.ft capacity, and run direct on a narrow gauge railway to the crusher or storage ground.

The method employed is expensive owing to the heavy overburden which averages 35 ft. and consists chiefly of clay. Cost could be considerably reduced and the output increased by the use of mechanical means, such as the use of steam shovels, deep blasting and the Telferage system of transmission from the quarry to the works; by such means the storage of large quantities of limestone direct from the quarries to the mouth of the crusher could with advantage be made, thus providing against possible shortage of labour.

Analysis of a sample of Katni limestone:—

	Per cent.
Loss on ignition	38·4
Insoluble matter	6·2
Soluble silica	3·1
Iron oxide	0·5
Alumina	1·9
Lime	47·8
Magnesia	1·5
Sulphuric anhydride	...
Total	99·4

Clay.—The supply of clay is practically inexhaustible and is rich in silica. As the wet process of the manufacture of cement is adopted by this Company it is necessary to reduce the clay by passing it through a wash mill to a consistency suitable for pumping direct to the kominor where it is mixed with the limestone.

Analysis of clay:—

	Per cent.
Loss on ignition	10·4
Silica	58·3
Iron oxide	4·5
Alumina	19·7
Lime	4·3
Magnesia	1·5
Total	98·7

Gypsum.—Gypsum used is to regulate the setting time and is added in suitable proportions during the grinding of the clinker.

Analysis of gypsum:—

	Per cent.
Loss on ignition	20·8
Insoluble matter	2·2
Soluble silica	0·7
Iron oxide	...
Alumina	0·3
Lime	31·1
Magnesia	1·4
Sulphuric anhydride	44·5
Total	101·0

Coal.—The class of coal used here should be as far as obtainable 1st class with a high calorific value and a low percentage of ash. From 27 per cent. to 30 per cent. of coal exclusive of that which is used in the power house is burnt per ton of cement, it is therefore one of the chief expenses connected with cement manufacture.

Process of Manufacture.—The cement is manufactured by the wet process. The limestone arriving in tip wagons from the quarries or storage

depôts is first dumped into a jaw crusher from which it passes up in an elevator to a reinforced concrete hopper over the kominor into which it is fed by an automatic feed table.

The clay is added to the limestone in the kominor, and the percentage is automatically regulated.

The mixture on passing through the kominor is again raised by a spiral conveyor to the tube mill where it is reduced to a fineness which ensures an intimate mixture of the lime and silica, etc., in the raw materials.

From the tube mill the slurry, as it now is, is passed by spiral conveyors to four correction bins in which revolving stirrers keep the mixture continually in motion. The slurry is here finally tested and any corrections in the mixture are made before being passed on to the feed mixers for the kiln in which there are also stirrers. The slurry is now ready to be calcined and is pumped up to the rotary kiln into which it is automatically fed. The firing of the rotary kiln is by means of coal ground to an impalpable powder fed in at the firing and under forced draught.

Analysis of fire brick used in lining of the rotary kiln :—

	Per cent.
Loss on ignition	0·4
Silica	76·9
Iron oxide	0·4
Alumina	21·2
Lime	0·3
Magnesia	0·3
	99·5

The clinker coming from the rotary kiln is passed through a rotary cooler into which cold air is forced. The clinker enters the cooler at a temperature of 2000° F. and leaves it at 150° to 200° F.

The clinker after leaving the cooler passes down a shoot into an elevator which raises it to a hopper situated on the clinker gantry where it is automatically loaded into tip wagons and weighed and then conveyed to the clinker shed where it is stored. From the clinker storage shed the clinker is conveyed in tip wagons to an elevator which again lifts it into a hopper above a ball mill which consists of a cylinder revolving around a horizontal axis with perforated plates around the circumference. The grinding is effected by means of steel balls which roll on the lower part of the mill and fall from plate to plate as the mill revolves thus crushing the clinker. The crushed clinker is thrown on to sieves on the periphery of the mill, that which is fine enough passing through and the residue returning automatically to the mill as it revolves for further reduction. The powder on passing through the ball mill is finally reduced in a tube mill to the fineness required in the finished cement.

The Portland Cement is now elevated to an automatic weigher and from there to a continuous belt conveyor into the storage bins. During the passage of the cement to the bins by the belt conveyor small quantities are mechanically picked up and dropped every few minutes into a tub which when full is brought to the test room for analysis.

Analysis of Katni cement from samples taken by Superintendent of Local Manufactures :—

	Per cent.
Loss on ignition	1·9
Insoluble matter	0·2
Soluble silica	19·6
Iron oxide	3·1
Alumina	8·8
Lime	62·1
Magnesia	1·9
Sulphuric anhydride	2·2
	99·8

GOVERNMENT TEST HOUSE.

ALIPORE, CALCUTTA.

REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT.
KATNI CEMENT COMPANY'S WORKS
Name and Brand of Cement—Katni (Sample A).
(Selected by Superintendent, Government Test House, personally on his inspection.)

—	Results obtained.	Standard (1915).
1.—Fineness of Grinding—		
Residue on mesh, 180 × 180 .	7·0 per cent.	Not more than 14 per cent.
Ditto 76 × 76 .	1·0 "	Do 1 "
2.—Specific Gravity	3 15	Not less than 3 10.
3.—Chemical Composition—		
Proportion of Lime to Silica and Alumina.	...	Between 2 85 and 2·0.
Insoluble Residue . . .	...	Not more than 1·5 per cent.
Magnesia	...	Do. 3·0 "
Sulphur calculated as $S.O_3$ . .	...	Do. 2·75 "
Total loss on Ignition . .	..	Do 3·0 "
4.—Tensile Strength (Neat)—		
7 days (average of 6 briquettes) lbs. (= W_n).	684	Not less than 450 lbs.
28 days (do.) lbs.	757	Do. $W_n + \frac{40,000}{W_n} = 742$
5.—Tensile Strength (Cement and Sand).		
7 days (average of 6 briquettes) lbs. (W_s)	356	Not less than 200 lbs.
28 days (do.) lbs.	406	Do. $W_s + \frac{10,000}{W_s} = 384.$
6.—Setting Time—		
Initial	74 mins	Not less than 30 mins.
Final	Under 7 hrs.	Not more than 7 hrs.
Classification	Slow.	
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould.		
(a) Cement aerated 24 hours	2 mm.	Not more than 10 mm.
(b) Cement 7 days test (a) having failed.	"	Do. 5 mm.

Proportion of water used in gauging—
(a) Neat briquettes . . . . 20 5 per cent.
(b) Cement and sand briquettes . . . . . 8¼ "
Temperature during period of testing . . . 80°—85°F.

GOVERNMENT TEST HOUSE.

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REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT.

KATNI CEMENT COMPANY'S WORKS.

Name and Brand of Cement—Katni (*Sample B*).

(Selected by Superintendent, Government Test House, personally on his inspection.)

——	Results obtained.	Standard (1915).
1.—Fineness of Grinding—		
Residue on mesh 180 × 180	13·5 per cent.	Not more than 14 per cent.
Do. 76 × 76	0·8 "	" " 1 "
2.—Specific Gravity	3·11 "	Not less than 3·10. "
3.—Chemical Composition—		
Proportion of lime to silica and Alumina.	...	Between 2·85 and 2·0.
Insoluble residue	...	Not more than 1·5 per cent.
Magnesia	...	" " 3·0 "
Sulphur calculated as $S.O_3$	...	" " 2·75 "
Total loss on ignition	...	" " 3·0 "
4.—Tensile strength (neat)—		
7 days (average of 6 briquettes) lbs. ($=W_n$).	653	Not less than 450 lbs.
28 days (average of 6 briquettes) lbs.	709	" " $W_n + \frac{40,000}{W_n} = 717$.
5.—Tensile strength (cement and sand)—		
7 days (average of 6 briquettes) lbs. (W_s).	361	Not less than 200 lbs.
28 days (average of 6 briquettes) lbs.	447	" " $W_s + \frac{10,000}{W_s} = 388$.
6.—Setting Time—		
Initial	118 mins.	Not less than 30 mins.
Final	Under 7 hrs.	Not more than 7 hrs.
Classification	Slow.	
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould—		
(*a*) Cement aerated 24 hours	1 mm.	Not more than 10 mm.
(*b*) Cement 7 days test (*a*) having failed.	...	Do. 5 mm.

Proportion water used in gauging –

(*a*) Neat briquettes . . . . 21 per cent.
(*b*) Cement and sand briquettes . . . . 8¼ "
Temperature during period of testing . . . . . . 85°—88°F.

Remarks.—This firm was the earliest of the three in the field and has been manufacturing cement for nearly 3 years. The works were first inspected by me at the Company's request in April 1915.

Until recently we have not made regular monthly tests of their product, but a large number of samples have been tested from time to time both for the firm and on behalf of purchasers, so I have had the firm's product under observation from the commencement. The tensile strengths of the cement both neat and with sand have been uniformly high and equal to those of first-grade English cement. Trouble was experienced over the question of setting time especially at certain seasons of the year, and cement which at the time of manufacture was entirely satisfactory in this respect was found to become quicker setting with age and aëration. I need not discuss the causes of this undoubtedly serious defect beyond saying that it was not due to lack of care and supervision on the part of the factory staff. Not only is the design and arrangement of plant entirely satisfactory, but the examination of the material at all stages of manufacture is complete and efficient. The firm appear to have overcome this difficulty now. The samples taken by me at the time of my recent inspection have been examined rigidly for this condition and have proved satisfactory, recent samples from other sources have confirmed the opinion and I do not anticipate a recurrence of the trouble.

Katni "Castle Brand" Cement as at present manufactured compares favourably with the standard English brands.

The Indian Cement Company's Works, Porbandar, Kathiawar.

These works are situated at Porbandar, Kathiawar, a Native State under British administration, on a site adjacent to the Docks and having a wharf frontage so that cement can be shipped [illegible] craft for distribution to ports in India, Persia, etc [illegible] Porbandar State Railway (Metre Gauge, [illegible] whilst for consignments booked to stations on the Broad Gauge transhipment is made at Viramgaum on the Bombay, Baroda and Central India Railway. The erection of the works was commenced in February 1913 and completed in October 1914.

Staff and Labour.—The staff consists of Manager and Chemist, both Europeans, two Assistant Chemists, Chief Engineer (Parsi), two Assistant Engineers and a Workshop Foreman. No difficulty is found in obtaining unskilled and semi-skilled labour of the class required. About 350 labourers both men [illegible] those engaged in quarrying. Men are [illegible] women 4 to 5 annas per day of 9½ hours. [illegible] ded for the employees.

Raw Materials.

Water.—An ample supply of water both for drinking and power is obtained from the Porbandar State. It is potable but hard and for boiler use is first softened to an average hardness of 6° in a Lassen and Hjert Water Softening Plant.

Limestone.—The limestone quarries from which the famous Porbandar Limestone, used so much for building purposes in Bombay, is obtained are situated near Ranawao, some 13 miles from the works, and chips are sent by rail from the quarries to the cement works. The limestone is a miliolite, almost white in colour, and practically a pure limestone. It is soft enough to be cut by saw and dressed with axes, and is practically homogeneous rendering selection unnecessary. Chippings sufficient for the factory's needs for 40 years have accumulated and the deposit of limestone is practically inexhaustible. The deposit extends along the base of the Barda Hills of silica (Granophyre) and the small amount of silica required to increase the silica content in the clay used is obtained by adding this Barda stone.

Clay.—Clay beds of a depth of from 6 to 10 feet occur near the works to the north and east and cover an area of several square miles. The deposits are alluvial and of uniform composition. No washing is necessary.

Gypsum—Deposits of needle-shaped pieces of gypsum mixed with clay occur on the marshes within a few miles of the works. The present development of these deposits supplies about half the factory's requirements, the balance being obtained from other places in Kathiawar.

Average Proportion of Raw Materials.

	lbs.	Percentage in mixture.
Limestone	987	77·90
Clay	168	13·26
Barda stone	112	8·84
Total		100·00

This gives a percentage of 75·0 to 75·5 of Calcium Carbonate.

Analysis of Raw Meal.

	From above material.		From chalk and Medway mud. Eng.
	Per cent.		Per cent.
Loss on ignition (CO_2, etc.)	34·60		34·68
Silica and insoluble ($Si.O_2$)	13·91		14·33
Oxide of iron (Fe_2O_3)	2·30	6·66	6·20
Alumina (Al_2O_3)	4·36		
Lime (CaO)	42·90		42·34
Magnesia (MgO)	1·50		·48
Alkalies and loss	·43		1·97
Total	100·00		100·00

Comparison of analysis with Medway cement mixture shows its similarity.

Analysis of Cement.

	Per cent.
Loss on ignition	2·50
Insoluble matter	1·12
Silica ($Si O_2$)	20·88
Oxide of Iron (Fe_2O_3)	4·03
Alumina (Al_2O_3)	6·57
Lime (CaO)	61·88
Sulphuric anhydride (SO_3)	1·55
Magnesia (MgO)	1·47
Total	100·00

Coal.—For power purposes 1st class Bagdigi coal was used until supplies were requisitioned by Government.

Coke.—Coke is used for firing the cement kiln. Until the difficulty of obtaining coal was felt a regular supply of low-ash coke was ensured by having furnace coke prepared from Bagdigi coal.

Description of Plant and Process of Manufacture.

The "Dry Process" is employed. The clay is dug from the river-bed and sun-dried, raised by an inclined belt conveyor into a pair of toothed rolls which break it up into small pieces, and then dried in a rotary coal-fired dryer. The dried clay is then elevated to a storage silo of 100 tons capacity from which it is automatically weighed and discharged into 10 cwt. Decauville tip trucks. Limestone and Barda stone are added in the correct proportions and the whole passed through a jaw crusher. It is then elevated into storage hoppers over two ball mills which reduce it sufficiently to pass through a 50×50 sieve, and is finally ground in a tube mill. This raw meal is elevated to four 120 ton storage silos placed next to one containing crushed coke. At this stage a proportion of coke is incorporated with the raw meal and the mixture of raw meal and crushed coke is then elevated to a damping worm where about 12 per cent. of water is added to it to make the mass sufficiently plastic to be compressed into bricks. Two brick presses produce per hour 3,000, 10″ × 4¾″ × 2⅜″ bricks, each weighing 9 lbs

The bricks are calcined in a vertical continuous kiln known as the Trachsler Kiln. It has four vertical shafts 42′ 0″ high by 7′ 6″ diameter constructed of reinforced concrete lined with fire-brick, the shafts being grouped together and surrounded by a cylinder of reinforced concrete the object of which is to prevent radiation and ensure uniform combustion The total height of the kiln as a whole is 72′ 6″ from a ground level and the maximum diameter is 56′ 0″. Bricks of raw meal are elevated to the charging platform and fed into the kiln by means of long shovels each layer being interspersed with a layer of coke. The coke incorporated in the bricks assists complete and uniform calcination. At the loading platform each shaft is separately connected by a damper with an electrically-driven exhaust fan; the temperature of burning is thus under control. The process is a continuous one; bricks being fed in at the top and clinker removed at intervals from the drawing eyes to a platform situated about 9′ 0″ above floor level. The clinker is first broken up in a jaw crusher, and the pulverization completed by passing successively through a Krupp No. 10 Ball Mill having an automatic feed of the shaker type, and a tube mill 26′ 0″ long by 5′ 0″ diameter. From ½ % to 1 % of gypsum is added to the clinker at this stage.

The cement plant was supplied by Messrs. Krupp of Essen, and the Company fortunately have plenty of spare parts. The grinders, elevators, etc., are rope-driven from a main shaft and outlying machines are motor driven.

Power is obtained for the main shaft from an 840 H. P. Hick Hargreaves Cross-Compound Surface Condensing Engine, and a 224 K. W. A. C. Generator driven from the main shaft provides current for the machine motors and for lighting purposes An auxiliary 250 H. P. Cross-Compound Engine, by Messrs Ruston and Proctor, coupled to a 150 K. W. A. C. Generator is used as a stand-by. Steam is supplied from a range of three 30′ 0″×7′ 6″ Lancashire boilers.

Samples of cement are taken at regular intervals during grinding and tested for fineness and setting time. These are all mixed every 24 hours, and a complete test made Further samples are taken at the time of bagging so that each consignment may be supported by test certificates. The cement is packed and sealed in stout jute bags, each containing 112 lbs. nett of cement.

Atmospheric conditions appear to have practically no influence on the quality of the cement. Grinding is a little more difficult during the monsoon owing to the clogging of the screens, but these effects of humidity are minimised by using exhaust fans The present output of the works is at the rate of 20,000 tons per annum.

GOVERNMENT TEST HOUSE,
ALIPORE, CALCUTTA.

REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT

INDIAN CEMENT COMPANY'S WORKS.

Name and Brand of Cement—Ganapati Brand Portland Cement (Sample A. B.)

(Selected by Superintendent, Government Test House, personally on his inspection at Porbandar on 5th July 1917.)

—	Results obtained.	Standard (1915).
1.—Fineness of Grinding—		
Residue on mesh 180 × 180 . .	7·1 per cent.	Not more than 14 per cent.
Do. 76 × 76 . .	0·2 „	„ „ 1 „
2.—Specific Gravity	3·10	Not less than 3·10.
3.—Chemical Composition—		
Proportion of Lime to Silica and Alumina.	...	Between 2·85 and 2·0.
Insoluble residue	...	Not more than 1·5 per cent.
Magnesia	...	„ „ 3·0 „
Sulphur calculated as SO_3 . .	...	„ „ 2·75 „
Total loss on ignition . .	...	„ „ 3·0 „
4.—Tensile Strength (neat)—		
7 days (average of 6 briquettes) lbs. ($=W_n$).	453	Not less than 450 lbs.
28 days (average of 6 briquettes) lbs.	514	„ „ $W_n + \frac{40,000}{W_n} = 541$.
5.—Tensile Strength (Cement and Sand)—		
7 days (average of 6 briquettes) lbs. (W_s).	204	Not less than 200 lbs.
28 days (average of 6 briquettes) lbs.	293	„ „ $W_s + \frac{10,000}{W_s} = 253$.
6.—Setting Time—		
Initial	105 mins.	Not less than 30 mins.
Final	Under 7 hrs.	Not more than 7 hrs.
Classification	Slow.	
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould—		
(a) Cement aerated 24 hours .	2 mm.	Not more than 10 mm.
(b) „ „ 7 days Test (a) having failed.	...	„ „ 5 mm.

Proportion of water used in gauging—

(a) Neat briquettes . . . . 19 per cent

(b) Cement and sand briquettes . . . . . . [illegible]

Temperature during period of testing . . . . [illegible]°—[illegible]° F.

GOVERNMENT TEST HOUSE
ALIPORE, CALCUTTA.

REPORT.

BRITISH STANDARD TEST FOR PORTLAND CEMENT.
INDIAN CEMENT COMPANY'S WORKS.

Name and Brand of Cement—Ganapati Brand Portland Cement (Sample C. D.).

(Selected by Superintendent, Government Test House, personally on his inspection at Porbandar on 5th July 1917).

—	Results obtained	Standard (1915).
1.—Fineness of Grinding—		
Residue on mesh 180 × 180	8·7 per cent	Not more than 14 per cent.
Do. 76 × 76	0·2 „	Do 1 „
2.—Specific Gravity	3·12	Not less than 3·10
3.—Chemical Composition—		
Proportion of lime to silica and alumina.		Between 2·85 and 2·0
Insoluble residue	..	Not more than 1·5 per cent
Magnesia	...	Do 3·0 „
Sulphur calculated as SO_3		Do. 2·75 „
Total loss on ignition	...	Do. 3·0 „
4.—Tensile Strength (neat)—		
7 days (average of 6 briquettes) lbs. (= W_n).	517	Not less than 450 lbs.
28 days (do.) lbs.	544	Do. $W_n + \frac{40,000}{W_n} = 594$
5.—Tensile strength (cement and sand)—		
7 days (average of 6 briquettes) lbs. (W_s).	215	Not less than 200 lbs
28 days (do) lbs	276	Do. $W_s + \frac{10,000}{W_s} = 261$
6.—Setting time—		
Initial	115 mins.	Not less than 30 mins.
Final	Under 7 hours	Not more than 7 hours
Classification	Slow	
7.—Soundness—		
Expansion after boiling 6 hours in LeChatelier Mould.		
(a) Cement aerated 24 hours	1·5 mm.	Not more than 10 mm.
(b) Cement aerated 7 days (a) having failed	...	Do 5 mm.

Proportion of water used in gauging—
(a) Neat briquettes . . . . . . 19 per cent.
(b) Cement and sand briquettes . . . . 8½ „
Temperature during period of testing . . . 84° — 88° F

Remarks.—It will be seen from the results of the tests of samples of this cement taken during my recent inspection that the tensile strength was not high enough to comply with British Standard Specification, 1915. On the other hand, other samples tested in the ordinary course of my work have sometimes complied fully with that specification.

Porbandar "Ganapati Brand" cement is sound, reliable, and suitable for all classes of work, but being of somewhat lower strength than rotary kiln cements is not so economical in use. In order to attain the same strength in construction it is necessary to use larger proportion of this cement in the mortar or concrete. This Company has already purchased a Rotary Kiln to be installed at an early date, with a view to increasing the tensile strengths of their cement at 7 and 28 days and so to bring it into line with other cements manufactured by the Rotary Kiln process.

Summary.

It will be evident from a perusal of this report that these three factories dealt with are all modern concerns located on convenient sites, dealing with entirely suitable raw materials equipped with up-to-date machinery, efficiently staffed and under expert European management; factories which compare favourably with those of well-known manufacturers at home. Success in producing cement of high quality depends to a great extent on the care exercised by the staff in keeping a constant check on the manufacture at all stages of the process. I was equally satisfied with the methods and staff employed by all these firms to ensure a uniform product. The samples taken at the time of my recent inspection were selected by me from storage bins, etc, and the results obtained by the tests made by my department are supported by tests made in the laboratory of the same brands from other sources tested at different times. These results show that Bundi and Katni cements, as at present manufactured, are equal to the best English brands, while the same is true of Porbandar cement except as regards its tensile strength which is somewhat low. All these cements are sound, reliable, and suitable for all classes of work. Imported cements are not infrequently found to have deteriorated during a voyage and Indian cements offer advantages in this respect also.

It is hoped that the publication of this report will serve to remove any prejudice against these brands of Indian cement which may remain in the public mind and lead to an expansion of the industry. The combined output from these three factories is at present half, or less than half, the amount imported into the country prior to the war so there is room for expansion. When cement has to be conveyed long distances by rail from the factory to the consumer the freight charges add greatly to the cost, and for this reason it is desirable that cement factories should be distributed over the country as widely as possible. A factory cannot, however, be set up in a place determined upon by these considerations alone. The location depends on the presence of suitable deposits of raw material, the cost of fuel delivered at the works and a multitude of other minor considerations.

HENRY A. F. MUSGRAVE,
Superintendent of Local Manufactures,
and Government Test House, Alipore.
Indian Munitions Board.

The Revenue Authorization Rolls for 1922-23 have been submitted on a new form which gives the fullest information and which will facilitate control. This work alone has entailed much labour and I am certain this would not have been done in the ordinary course of events. The fact that I returned from leave at the end of January and Mr. Warren did not go till the end of April enabled the latter officer to utilize my services in the interval in this and other pressing work.

As regards re-organization of work, a programme has been submitted to the Board. I propose, if invited to do so, to discuss the matter before the Board when it meets.

As regards motor trollies, 2 have been provided and these are most useful and we are making enquiries regarding a 3rd.

As regards the Loco Department another Assistant has been engaged and a special inspection of the accounts of this Department is being made by Mr. Wilby. His report should indicate considerable re-organization resulting in economy.

More subordinate Superintendents have been engaged and although we are not yet at full strength we have sufficient men, I consider, under present conditions.

As regards the Provident Fund we have placed Sir Francis Couchman's suggestions with certain amendments before the Public Works Member of Council, Bikaner, and the Finance Member of Council, Jodhpur. We have also referred the Banking question to the Railway Board in Simla and have asked the Finance Member of Council, Jodhpur to represent this question to the Government of India through the Foreign Department.

The Marwar Junction-Desuri Line has been closed down.

Enquiries as regards a Creosoting Plant for sleepers have been made but I am inclined to think that soft wood sleepers are a waste of money and am hoping to purchase hard wood sleepers which will not require treatment or steel trough sleepers.

Sir Francis Couchman has modified his first proposals somewhat in his second Note dated February 1922 and this second Note has received and is receiving attention.

Sir Francis Couchman's recommendations which apply solely to the Jodhpur Railway should be easy to carry out since all that is required is the approval of the Marwar Durbar but when these recommendations refer to the system as a whole action is not so easy since action also requires the approval of His Highness' Government in Bikaner and I cannot help feeling that it would be advantageous to divide the report into 2 portions in future-one part dealing solely with the Jodhpur Railway and the other part with joint system - if this latter part were also signed by the Adviser to the Bikaner Government business would probably be expedited. I prefer not to put this suggestion forward officially.

J. FEARFIELD
AG. Manager,
J. B. Ry.

Dated May 15th, 1922.

Note
On the Jodhpur Bikaner Railway.
February 1922.

(1) This Note must be considered to be in continuation and amplification of my Note of April 1921. In that Note I endeavoured to describe briefly the history and present position of the Railway and to put forward proposals as to the policy which should be adopted for improving financial control, and for taking in hand new works and improvements to enable the line to meet the probable demands on it.

The proposals suggested involved a considerable amount of spade work in the preparation of detailed statements, plans, estimates, etc., and I hoped that these might have been ready for examination during my present visit at Jodhpur. A good deal of work in this direction has been done, probably as much as could reasonably be expected under the circumstances; but a good deal still remains to be done before final conclusions can be arrived at.

(2) The general position at present is that the Jodhpur Bikaner Railway, like pretty well everything else, is suffering from the after effects of the Great War. Local traffic has been good, but the lucrative through traffic has fallen off, due to the universal slump in trade. Arrears in maintenance and renewals, and in improvements and additions, have had to be faced, and the cost of working has greatly increased owing to the all round rise in prices. The result has been a large falling off in revenue earnings, with a great increase in expenditure; and though the introduction of new higher rates from 1st April should increase the earnings, it is still necessary to curtail expenditure as much as possible in the immediate future. Present position.

The policy to be pursued at present is then to endeavour to set the house in better order as regards financial control, and efficiency of working, and, while elaborating programmes, to provide for such works and additions as appear to be required, to confine expenditure for the time being to the minimum necessary to meet urgent requirements. It is first necessary to consider how far these questions are likely to be affected by either the introduction of the Broad-gauge, or the separation of the systems owned by the Jodhpur and Bikaner Durbars.

(3) So far as the former is concerned the increased demands on, and the arrears of maintenance, etc., to be made up on the existing Railways in India are so great, that expenditure on new constructions must for some time to come be strictly limited to projects of the most urgent nature. The proposed through Broad-Gauge connection to Karachi involves very heavy expenditure, with a somewhat doubtful return on it, and cannot Proposed Broad gauge.

in any way be classed as urgent. Consequently, so far as can be foreseen at present, it may be accepted as being outside practical politics for a good many years to come. All that is necessary, then for the present, is to bear in mind that, though from the Jodhpur point of view its construction should be put off as long as possible, it is pretty certain to come sooner or later, and that any big alterations or additions should be so designed and carried out as to provide for its eventual introduction.

eparation of System.

(4) As regards separation of system, I understand the Bikaner Durbar contemplate making a commencement on building new Railway Workshops at Bikaner next cold weather, and separation must, therefore, be reckoned as a practical possibility in some 5 years' time. Though the present joint ownership of the system necessarily involves certain difficulties and complications in working; from a purely commercial point of view, the separation of a medium sized railway system, into two smaller ones cannot be regarded as likely to result in economical working, or under existing conditions to be financially to the real advantage of either State.

inancial control.

(5) The first essential to obtain efficient financial control is the introduction of a form for the Capital and Revenue Budgets and Authorization Rolls which will render it possible to see clearly the expenditure provided for under each head and item for both establishment and material and to compare it with the same for the previous two years. On the Jodhpur Bikaner Railway matters are complicated by the fact that figures for the whole system are required for the Railway financial year, April to March, and for each of the Durbar systems for the Durbar years. The question then is how to obtain efficiency and at the same time avoid unnecessary repetition and labour I would suggest that full detailed budgets and rolls be drawn up for the Railway financial year and that these be considered as the actual authority for expenditure, and that abstracts, based on these, be drawn up to supply such information as is required for the Durbar years.

For this purpose I do not think the railway could do better than adopt the form used by Government State Railways which provides for full details, supported where necessary by explanatory notes. The Revenue Budget distinguishes between ordinary, fuel and 'programme', the latter being based on a schedule of works in order of urgency, showing those already in hand, and to be started during the year, with estimated cost, amount already spent, and to be spent, during the year, in each case.

The Capital Budget consists of a similar schedule for new works chargeable to capital. Both these schedules should be based mainly on accepted programmes of renewals, replacements and improvements.

I understand that the budgets for the coming year, which are now under preparation, are being drawn up very much in accordance with these recommendations, and that the preparation of certain information which the Railway Board have called for, will considerably facilitate the preparation of the complete programmes previously recommended.

(6) So far as the Jodhpur State is concerned funds for both Capital and Revenue Expenditure have, I understand, been supplied from the same source, *viz.* State balances. The opinion has been expressed that this policy involves the starving of other interests, such as education &c. at the expense of the Railway, and it appears probable that this must sometimes be the case. The generally accepted principle is that Capital pays for all new works, additions and improvements, and that Revenue maintains everything at the standard provided by Capital. On Government Railways Capital requirements are supplied from loan funds, and Revenue from current receipts. As railways invariably tend to expand, expenditure on Capital Account must always be reckoned on.

Provision of Funds for Capital and Revenue.

7. I do not think much practical good can now be obtained by any close examination of the current year's budget. It has already been revised once and much of the essential expenditure provided for has already been incurred. On the other hand, owing to the delay in sanctioning the budget, the provision included for several works will not be spent. There are large increases under wages and supervision. I find it practically impossible to examine these without more detail, but there is no doubt that under existing conditions increases under these heads have been inevitable.

Current year's budget

There is a very large increase under Abstract A, mainly due to heavy permanent way renewals to eliminate the inferior and light rails on the Merta Road-Bhagu Section. These renewals are required, but have apparently been carried out more rapidly than they need have been in order to find second-hand material for the Desuri Branch. The debits and credits between Capital and Revenue on account of new material put in, and old material removed, are somewhat of a puzzle. I see no reason why these should not in future be maintained to show the transactions actually carried out each year, all new material put in the road being debited to Revenue and all second-hand material taken out, debited to Capital Suspense. As this latter does not involve a cash expenditure, it should not be included in the joint account on which interest is charged There should be a considerable reduction under this head in future.

The increase under Loco: expenses is mainly under fuel and is, I fear, likely to be permanent and in, fact, probably further increased.

The estimate for revenue receipts appears to be a fairly safe one and if export recommences, or the proposed increased rates brought in, should be exceeded.

Certain further directions in which improved procedure appears desirable are now considered.

8. The workshop accounts are at present maintained by the Loco. Foreman. This is a survival of old times when the shops were smaller and the accounts much less important than they now are. They should be taken over as soon as possible by the Auditor even though his office may require strengthening for the purpose.

Workshop and Stores Accounts.

There are, at present, considerable facilities for leakage of stores, both at headquarters and at out-stations. The Stores Department itself is considered later on. It will be sufficient to say here that a properly organised combined Loco. Stores to control all issues to running sheds is an urgent need and that the whole of the Loco. shop area should be fenced in as soon as practicable. The Manager has suggested that Mr. Wilby the officiating Auditor, who will shortly be relieved by the return of Mr. Harrison, should be retained to thoroughly examine and go into the procedure and account methods in use in the Loco: shops and Stores yard. I have already strongly supported this suggestion: such an overhauling is greatly required, and Mr. Wilby is a very suitable and well qualified man for the purpose.

Out-door Inspections.

9. More out-door inspection work is required by the Officers of all Departments, and the payments of staff should be made more frequently by officers. Far too much of the time of all Officers is at present taken up in office work and routine. This is a position which not unfrequently arises as a railway develops and must be guarded against. To maintain efficiency constant supervision is necessary in all departments. I consider the question of increase in staff below: the essential is to reduce office work as far as possible and to arrange that most routine work is disposed of by junior officers.

As previously suggested I think the use of motor trollies would enable officers to inspect more efficiently and frequently and to economise their time. Two such trollies have been obtained but these do not appear to be altogether suitable. An officer on inspection frequently wants to take another man or two along with him, and trollies should be designed to carry 5 or 6 people comfortably and might well be built in the Loco: shops with imported engines.

Superior staff.

10. While I fully recognize the necessity for economy which exists at present, I think there is no question that the railway is under-officered at present, and that the majority of the Executive Officers have far too much of their time taken up in claims and routine work, and are consequently unable to devote as much time as is desirable to out-door inspections. I also think that the present custom of officers working in their own bungalows must lead to waste of time and avoidable references. The only officers who actually work alongside their clerical establishment are the Loco. Supdt. and Auditor. Officers must of course often work in their bungalows, but I think it would tend to both efficiency, and reduction of work, and possibly also to reduction of clerical staff if the Manager, District Managers, and their Assistants, attended the general offices during ordinary office hours. I fear this will involve additional office accommodation, but it would be money well spent. I also think it would lead to efficiency if a senior assistant had his headquarters at Mirpur Khas. There is no great urgency about these alterations but it is a question the Manager should take up at once and carry out as soon as practicable.

Traffic Department.

11. I previously recommended the addition of a trained traffic officer with the status of Deputy Manager to take over all claims and commercial work generally. I still think the proposal sound in principle, but after

further consideration think the introduction of a senior officer from outside would be hard on the existing officers, and also that the introduction of a Deputy Manager might be postponed until more prosperous times. I think that the present method of working both the Engineering and Traffic Departments with District Managers is very suitable for existing conditions on the J. B. Ry. and is both efficient and economical; there is, however, an urgent necessity to relieve these officers of as much routine work as possible. The most economical way to improve matters for the time being would I think be the appointment of an experienced subordinate with the rank of Hon: officer to work under the Manager to dispose of all claims work. A further point in this connection is that the experience obtained by the J. B. Railway officers is confined to their own railway and, therefore, necessarily somewhat limited. I think advantage should be taken of any possible opportunity to enable any of them to visit other Railways and see what is done there, and so far as traffic matters are concerned I feel sure it would be advantageous if the services of a really experienced Traffic Officer, such as Mr. Hanson, could be obtained to visit the Railway for a week or two next cold weather, and look into and advise as regards the details of traffic working The permanent appointment of a new Traffic officer might lead to differences of opinion as regards the present system of working but much useful advice could be obtained from a really experienced Traffic Officer.

12. I think the time has arrived when the appointment of a second Assistant Auditor is required. At present the Auditor with one Assistant runs the whole of the Audit and Pay Departments The time of the Assistant Auditor is entirely taken up with Traffic Audit and the Auditor has far too much of his time taken up with purely routine matters. Inspection of stations and other outdoor work is consequently practically impossible, such inspections are very desirable and in fact essential for maintaining efficiency. The appointment of a second Assistant Auditor would also enable the Audit Department to take over the accounts of the Loco: shops which have hitherto been maintained by the Loco· Foreman and probably permit of a reduction in Clerical Establishment. Audit Department

13 I am still of the opinion expressed in my previous Note that the Loco. Department should be strengthened by the appointment of an additional officer and that such is necessary for efficiency. The present establishment consists of the Loco Supdt, his Deputy, and an Assistant. No allowance is made for leave or casualties. For some time there has never been more than two, and sometimes only one, officer on duty, while to carry on, Mr. Lean the Head Foreman has been appointed to officiate as an officer. Mr. Rogers, the Deputy is at present on leave and I understand it is doubtful if he will return or at any rate stay much longer and Mr. Lean requires, and must be given, long leave very shortly. The minimum establishment for efficiency is the Loco: Supdt. in general charge, an officer in control of running, a works Manager in-charge of the shops and an Assistant to relieve the Loco Supdt. of routine work and be available for relief. I think Mr. Lean, who has proved himself to be an old and Loco Department

trustworthy servant, might well be given the rank of Honorary Officer and be considered as the permanent Works Manager but unless Mr. Rogers returns before Mr. Lean goes on leave another officer will be essential at once.

Subordinate Staff.

14. I understand the Railway is now fairly well off so far as subordinates are concerned, but as soon as claims work is concentrated in the Manager's Office the appointment of one or two claims Inspectors will be needed. The appointment of European Traffic Inspector at Mirpur Khas appears desirable, and should more than pay for the extra cost. The drawing up of incremental scales for all subordinate and menial staff is in hand. The sooner these are completed and brought into use the better.

Staff Quarters.

15. The conditions on the Jodhpur Bikaner Railway are such that wherever an officer is posted he must be provided with quarters. The same applies generally to all staff except at a few of the larger towns.

All the officers on the line are well housed at present, but at Jodhpur there is only just sufficient accommodation, and it is probable another bungalow will have to be built before long. The cost of the bungalow recently built was very high. It is very desirable that men who have to spend the greater part of their life in Jodhpur should be well housed, and the accommodation provided in the existing houses does not appear to be excessive, but I think that in future a good deal of economy could be obtained by adopting a simpler style of building and cutting out ornamental stone work.

A bungalow is required at once at Mirpur Khas for an Assistant Officer. The N. W. R type of Assistant's house would probably be the best to adopt in this case.

A considerable number of menial quarters have recently been built all over the line, and a considerable number more are provided for. This is an expenditure which must be incurred without undue delay.

Rent of staff quarters.

16. Up to 31st March [illegible], all staff quarters on the Jodhpur Bikaner Railway were supplied rent free. [illegible] the pay and prospects of the railway officers were improved by the introduction of the incremental scales of pay adopted for officers on State Railways, and with a view presumably of bringing these officers to the same position as those on State Railways, it was decided that in future they should pay rent on their houses in accordance with the rules adopted on State Railways. These rules provide for a percentage on the actual booked cost in each case, and as the cost of construction has very largely increased in recent years it follows that the rent of the more recently built bungalows is proportionately greater than the older ones, and in some cases junior officers occupying smaller houses pay higher rent than their seniors in larger ones. This is evidently not desirable, and it would seem fairer to base rent either on plinth area, or a percentage of salary.

As regards the intention to place the J. B. Railway officers on equal terms with those of State Railways it should, I think, be realised that the prospects of the latter, so far as higher appointments open to them and

serving in hill stations, are very much better. On the J. B. Railway there is only one highly paid administrative appointment, which only a small proportion of the officers can hope to reach. The Railway Officers are moreover, the only employees of the Durbar who pay house rent. I think, therefore, they might well be treated liberally in this respect, and would suggest that each officer pay 5% of his salary to cover house rent and customs. It is a comparatively small matter, but it is often that small matters such as this produce a feeling of irritation, or satisfaction out of proportion to the interests involved.

There is one other point in this connection. When the pay of the other officers was raised, no increase was made in that of the Manager, although he has since had to pay house rent. This matter needs putting right. I would suggest the pay of the post be increased to rise to Rs. 2,500.

17. In my previous note I said that the same procedure should be followed as is adopted on State Railways, *i e*, a cent per cent bonus, and interest at 5½%. As a matter of fact it is definitely laid down in the agreement of each officer that he will subscribe to a Provident Fund which will be similar to that on State Railways Provident Fund

The Fund has in the past been run on lines similar to those usually adopted on Indian Railways It has been managed by two Trustees, the Manager and the Auditor, the accounts being kept by the latter. It receives the members' deposits, interest on securities, and a half-yearly contribution from the railway, not exceeding the deposits of members, and limited to 1 per cent of gross earnings of the railway Payments are made to each retiring member of the sum standing to his credit, and the balance invested from time to time by the Trustees.

The bonus credited half-yearly to members has usually been cent per cent on their subscriptions, but latterly owing to falling off of receipts it has been considerably less.

Owing to the great depreciation of the securities held the Fund is now not in a solvent condition. The question is how to make it so. As there are 3 partners interested in it, *viz*, the two Durbars and the Government of India, it is hardly practicable for the Fund to be taken over as has practically been done by Govt. on the State owned lines I would suggest the following procedure:—

(1) Value the assets, *i. e*, the investments and cash, on a specified date.

(2) Make out a statement of liabilities, *i. e*, face-value of deposits, and bonus and interest due to members. Since the officers joined the Fund on the understanding it was to be maintained as on State Railways, they have, I think, a claim to the face-value of their subscriptions with bonus and interest.

(3) Make out a balance sheet showing deficit.

(4) Proceed to form a sinking fund to meet this deficit by a half-yearly levy on the railway Revenue so as to make the fund solvent in a specified term of years. As there is a possibility of a separation of the system in some 5 years' time it would be well to fix that period for making the Fund solvent,

Though it is only the officers who can claim a similar treatment to State Railways, it would be both undesirable and difficult to have different rules for them and subordinates, and the latter should, therefore, be given the same rules as the officers.

I think that on the J. B. Railway little or no advantage would be obtained by allowing daily paid workshop employees the benefits of the Fund, and that these benefits should be confined to bona fide monthly paid staff.

The Banking question.

(18) The point at issue at present is the rate of interest to be paid to Jodhpur by the other partners of the system, *viz.*, Bikaner and the Government of India, on the outstanding balances at debit of Stores and Miscellaneous Suspense accounts, which are financed by Jodhpur The rate which was fixed many years ago, when conditions were very different, was $4\frac{1}{2}$ % which rate is still being paid. It is clear that if $4\frac{1}{2}$ % was a fair rate say 10 years ago, it is not so now. The Railway Board have been addressed on the subject by the Manager, and asked to agree to raise the rate by $2\frac{1}{2}$ % to 7 %. The increase of $2\frac{1}{2}$ % having been fixed by the Railway Board in a very similar case. The Bikaner Durbar have agreed to the proposed increase as reasonable. The Railway Board, however, declined to do so, though they have given no satisfactory reason. The claim is unquestionably a reasonable one and should be submitted at once through the Resident to the Government of India.

Rolling Stock for the British Section.

(19) This is a somewhat similar issue to the previous one. Under the contract with the Secretary of State for working the British Section, the Jodhpur and Bikaner Durbars undertook to supply rolling stock, receiving 5 % of gross earnings for doing so. This was subsequently altered to 5 % on the capital cost of the stock required to work the line, the proportion of the total stock on the combined system being based on gross earnings. Here again if 5 % was a fair rate before the War it is evidently not so now, and there is no doubt that at any rate so far as the capital expenditure incurred since rates went up, which is considerable the rate of interest might reasonably be raised by $2\frac{1}{2}$ per cent. As regards the capital previously incurred the position is that so far as the two Durbars are concerned their money is locked up and they are not obtaining the value for it they otherwise could do. This question has also been referred to the Railway Board without result and should now be referred to the Government of India by the Resident

Surtax.

(20) Under the orders of the Railway Board a Surtax, based on freight, has been levied on all traffic originating or terminating on a foreign railway, and the Railway have been told to hand over the whole of this to Government. So far as this tax refers to freight earned in either the Jodhpur or Bikaner States it is practically a tax levied on those States, and should therefore be, retained by them.

A further point is that within the Boundaries of the States the railway is not so far as I can gather from such contracts as are available, governed by the maxima and minima rates and fares as laid down by the Government of India, except in so far as it has bound itself by accepting Conference regulations.

(21) I think a good deal might probably be done by extending the 'building stone' traffic from Jodhpur. The first essential for this purpose is to construct a siding to the quarries. A survey for this is, I understand, in hand. This should be expedited and the siding put in as soon as possible. I gathered that there is a possibility that the Surtax now levied on all through traffic was adversely affecting this traffic. This matter needs looking into, but the cost of leading by camel to the nearest railway station is at present so great that the construction of a siding to the quarries would probably enable rates to be increased. *Possibilities of increased traffic.*

The Station Master at Pipar Road informed me that if the light branch from that station was extended some 12 miles or so, a large additional traffic would be obtained. This should be looked into. I think when more prosperous days returned it would probably pay to convert this branch line to metre-gauge. As second-hand rails and sleepers are available the expense should be small, and the convenience be considerable.

22. In my previous Note I detailed the various programmes of additions, renewals and improvements which should be drawn up to provide for maintaining the line in an efficient state and raising its capacity to deal with possible demands. I still consider the preparation of such programmes an urgent matter, but under existing conditions it is necessary to consider how far it is desirable to provide for a greater carrying capacity and increased efficiency at once and how far provision may be deferred. *Expenditure on improvements and renewals.*

A very large number of new engines have been obtained recently and a heavy programme of permanent-way renewals nearly completed. The line is still very short of coaching and goods stock especially the Jodhpur System, but the Railway is now in a position to deal with the traffic at present offering, and with comparatively little further expenditure should be able to deal with any ordinary requirements.

Conditions at present appear to be so uncertain and the necessity for economy so important that it is desirable to call a halt to expenditure and to provide only for maintaining the line its present condition and to limit improvements to such as are of a really urgent nature.

23. On completion of the relaying in hand between Merta Road and Bhagu wholesale renewals should be stopped. *Permanent Way.*

Isolated rail renewals will, of course, be required from time to time in cases where rails are badly worn or have corroded as in parts of the Sind Section. Most probably it will be possibe to provide for these from stocks in hand. *(i) Rails.*

Sleeper renewals must continue to be heavy owing to the large arrears to be made up *e g*. Most of the sleepers between Luni Junction and Hyderabad (Sind) are well over 20 years old and are rapidly approaching the end of their life. *(ii) Sleepers.*

The difficulty here is to obtain sufficient serviceable sleepers to meet requirements. Hitherto Deodar have been mostly used, but these must, I fear, now be reckoned as impossible to obtain at a reasonable price, since

the demand for that timber for building purposes practically monopolises the supply. Good *sal* sleepers are being obtained through the R. & K. Railway at about Rs. 3/- each plus freight, the supply is strictly limited but as many as possible should be obtained. To meet urgent requirements creosoted 'Chir' have recently been obtained in considerable numbers from the Punjab. These cost, including treatment, about Rs. 4/-plus freight. *The treatment at present consists of dipping only and is likely to prove of* little use. To make these sleepers reliable they should be creosoted by some efficient process, and should also have bearing plates. The latter would add between Rs. 2/8/- and 3/- per sleeper, and there are so far no facilities in India for the former. I think, therefore, the use of these sleepers should be discontinued at any rate until further experience has been obtained of them. Half round Indian teak sleepers are now being tried, they may prove satisfactory, but are awkward looking and can at present only be considered in the experimental stage, both as regards supply and *efficiency.*

The most suitable sleeper for the greater portion of the line is undoubtedly the steel trough. They make a good road and under favourable conditions practically last for ever I think inquiries should be made from the Consulting Engineers regarding the price at which these can now be *obtained, and also, as regards a possible improvement in the design. With* the great fall which has recently occured in the price of steel it seems possible the use of steel sleepers can with advantage be considerably extended, but before purchasing any it is desirable to make enquiries from home as suggested.

Steel sleepers, however are not suitable *for salty tracts or on soft banks* and a considerable number of wooden sleepers will always be required. I have lately looked into the possibility of a supply from Burma It is unfortunate that during the War, and immediately after, large quantities of very inferior sleepers were obtained from Burma for Indian Railways at high prices, and that consequently they have obtained a bad name I am, however, convinced that, by going to the right source, good sleepers can be obtained at a reasonable price from that country. I think Pyingado could probably be obtained at Karachi at about Rs. 5/4/- and Thitya Ingyin for about Rs. 4/12/- both of really good quality.

Crossing and bridge timbers of any size could, I understand, be obtaine at about Rs. 4/12/- and 4/4/- per cubic foot respectively at Karachi. I am making further enquiries as regards these, and if satisfactory I think it would probably pay the Railway to obtain a sample shipment at Karach to meet immediate needs rather than get any more Chir

Locomotives.

24. Thirty new standard M. & P class engines have recently bee added to the line, the total number now being 132 of which 36 belong t Bikaner. The line is now well equipped in this respect and should be abl to meet any demands which may be made on it.

A number of the older engines are nearing the end of their economic life, and will before long have to be scrapped, but there are still many sectio on which only light types can be used and there are no Engines on the li-

at present which cannot be usefully utilised. No additions or replacements are, therefore, called for immediately, though it would be good policy to provide for some replacements as soon as funds permit. With the additional power now available it is intended to dispense with the unsatisfactory pracitice of running double crewed engines. This is desirable, but will entail some expense in additional facilities and staff quarters at certain engine changing stations, notably Barmer.

With so many new engines the cost of repairs will be considerably reduced for the next 2 years. After that it will be necessary to have increased shop facilities for dealing with the additional number on the line On the separation of the system, however, the position will again be much the same as it has been hitherto.

(25) There is a great shortage of coaching stock on the system, and it is necessary to keep every vehicle which is at all fit to run on the road. Many of the old 4-wheeled carriages are of a great age, and must be near the end of efficient service. There are, however, none so far which cannot be usefully employed, though it is proposed to degrade some of the older upper class stock For the same reason, it is frequently not possible to send vehicles to shops for repairs as often as desirable, and consequently the condition of much of the stock leaves a good deal to be desired. It is evident then that there is an urgent demand for further new stock, and provision should be made at once for as many new bogie vehicles, of the latest types, which the shops can turn out without working overtime. Coaching Stock.

(26) As previously stated, the line is short of goods stock, and though under present conditions there is no necessity for an immediate heavy outlay on additions, further additions should be made whenever opportunity occurs. At the present time it will be sufficient to complete the stock provided for in the current year's budget. Goods Stock

No renewals or replacements have yet been made by Revenue, but certain old vehicles have been sold to the Salt Department. I understand there are at present no vehicles which cannot usefully be utilised.

(27) As noted last year, the shops are behind the times and now barely capable of meeting the requirements of the line. A rough plan has been drawn up to show the re-arrangements and additions to meet the needs of the Broad-gauge, this plan should be completed as far as it is possible to do so at present in order to show what areas may eventually be required and enable them to be earmarked for the purpose. In view, however, of the probability of new shops being built at Bikaner in the near future, and the general uncertain position at present, expenditure should be confined to immediate essentials. Locomotive sheds.

I do not think there is any urgent need to move any of the shops as now existing, but the removal of the tiffin sheds from their present position is desirable They not only interfere with the much needed improvement of the traffic yard, but encourage men to trespass about the station yard.

Hitherto in addition to carrying out all repair work to maintain locomotive, coaching and goods, stock, in efficient condition, all new coaching and goods vehicles have been entirely built at Jodhpur from raw material. With the recent great rise in cost of Indian labour, the indifferent facilities provided in the shops, and the heavy drop in prices of imported manufactures, I think it is very questionable if it is now really advantageous or economical to continue this practice, which is one not usually adopted on Indian Railways. I think this question should be carefully gone into, it being also taken into consideration that any reduction themselves of work which can be introduced will obviate expenditure on the shops I am inclined to the opinion that the wisest policy at present would be to confine the shops as far as possible to repair work, and to obtain new wagons and carriage underframes complete, and merely erect them at Jodhpur. I, however, think that considerable economy could probably be obtained by manufacturing all signals, interlocking and other such plant required by the Engineering Department in the shops Wagon building has been much specialised in, by private firms both in England and India and keen competition has brought prices down. Signal and inter-locking plant, on the other hand, is practically confined to one or two firms and prices are very high

The shops at present most in need of improvement or enlargement are the Smithy, Foundry and Boiler, Shops The Smithy is not only cramped but very hot, and shut off from all breeze I doubt if much real improvement could be obtained without completely moving it, but if the suggestion made above is accepted the amount of work to be done in it will be considerably reduced and it can probably be made to meet requirements for the present An item of work which I think needs improvement is springs All springs are built up in Jodhpur, but the facilities for doing this have been poor. A new furnace is being introduced which should improve matters, but I think some Hydraulic plant is also required before efficiency can be obtained. A drop hammer is also required in the Smithy.

The position of the Foundry is somewhat similar to that of the Smithy I doubt if it is possible to reduce much work in this shop and an early move may be unavoidable. For the present it can I think carry on.

The Boiler Shop is a portion of the engine repair and erecting shop. Owing to the bad water in many parts of the line, boiler repairs are unusually heavy, and the additional engine stock now on the line will increase the amount of work to be done. The position will be relieved by the Bikaner shops, but an early extension of this shop will probably be needed, and an estimate for it should be drawn up.

Another very heavy item of work on the J. B. Railway is turning up tires. Owing to the large amount of blown sand on the desert sections, tires wear more rapidly and have to be turned up much oftener than on most lines. A new wheel shop has lately been completed, but to deal with the increased stock an addition of one engine, and two wagon, wheel lathes will be required during the next 2 years.

The efficient fencing in of the whole shop area, with the provision of only one means of entrance and exit, is, I consider, an urgent work and one which would soon pay for itself, by putting an effectual check on thefts and on workmen loafing. Where there is a well defined permanent boundary a wall should be built, otherwise unclimbable fencing which can be moved from time to time is necessary, and which could probably be made up in the shops from old material.

28 There are 3 main points to be considered in connection with stores:— General Stores.

(i) That sufficient and suitable accommodation is provided for the custody and safety of all articles.

(ii) That the procedure adopted for the receipt, issue and accounting of transactions is efficient and brings to light at once any leakage.

(iii) That attention is paid to keep down stores balances by proper scrutiny of indents, by utilising stocks in hand as far as possible, and by avoiding large stock of spares.

As regards (i), the present Store yard is faulty and inefficient. In my last Note I recommended its removal to another site, mainly to permit of shop extensions. On going more into detail it appears that a satisfactory arrangement can be more economically obtained by moving the present store yard further back. The requirements which should be provided for are:—

(i) To arrange all classes of stores methodically without overcrowding.

(ii) To place all perishable articles under cover, and valuable articles under lock and key.

(iii) To enclose the whole yard with an efficient fence or wall.

At present the various classes of stores are much mixed up, and the space available is insufficient. Shedding is both insufficient and inconveniently placed, and many articles which should be covered are in the open. The question has recently received considerable consideration, and the Lucknow stores have been visited. The resulting conclusions for remodelling the stores yard were explained to me and seem sound. A detailed plan and estimate should be drawn up and the work taken in hand as soon as possible The new store yard should provide for the removal to it of all the stores at present lying on the other side of the Railway.

As regards (ii), the whole procedure is, I hope, to be shortly examined in detail by Mr. Wilby and further consideration may well await his report.

As regards (*iii*), the following statement shows the rapid growth of stores balances during recent years:—

Statement showing "Grant" & "Expenditure" under the head "Stores Transactions" for the years 1912-13 to 1919-20.

Years.	Grant.			Expenditure.		
	Receipts.	Issues.	Net debit to Stores Transactions.	Receipts.	Issues.	Net debit to Stores Transactions.
1912-13	12,06,500	10,00,000	2,06,500	18,60,677	14,43,942	4,16,735
1913-14	13,06,500	12,00,000	1,06,500	16,25,794	14,11,775	2,14,019
1914-15	20,18,000	19,00,000	1,18,000	27,70,181	27,33,100	37,081
1915-16	17,00,000	16,00,000	1,00,000	31,49,208	29,63,126	1,86,082
1916-17	28,00,000	27,00,000	1,00,000	31,43,992	31,44,578	586
1917-18	32,00,000	30,00,000	2,00,000	40,74,843	38,35,503	2,39,340
1918-19	34,62,678	31,62,678	3,00,000	63,47,803	56,71,982	6,75,901
1919-20	55,81,000	51,81,000	4,00,000	30,56,485	30,54,723	1,762
1920-21	43,65,545	......	6,00,000	......	......	......
	5,00,000	37,65,545	5,00,000	67,55,129	35,86,307	11,33,398

NOTE:—The years relate to the period from 1st October to 30th September.

The main items are the following:—

	November 1919.	November 1921.
Coal	4,25,000	3,25,000
Metals	3,60,000	3,50,000
Nails &c	45,000	75,000
Tools	34,000	60,000
Pipes, &c.	34,000	56,000
Carriage fittings	3,55,000	7,00,000
Engine	4,69,000	9,00,000
Permanent Way material	1,73,000	6,75,000
" 2nd hand	1,99,000	71,000
Electrical fittings	24,000	1,42,000
Loco imprest	17,000	15,000
Workshop Suspense	24,000	61,000
Total balance ...	24,69,000	36,00,000

These are large figures and the increases have been very rapid. I noticed very large stocks of fire-box plates, engine and wagon tires, boiler plates, &c.; and it is, I think, clear that Loco spares and requirements have accumulated to too great an extent and new orders are placed without sufficient consideration of what is already in stock.

I am inclined to think that it would be a step towards efficiency if the Loco Department took over charge of most of their own material and keep it separately in a Stores Depot of their own and think this might be considered by Mr. Wilby in consultation with Mr. Stirling.

29. The cost of Bengal coal has increased enormously during recent years, and as far as can be seen is likely to increase further. Owing to railway strikes, and troubles with cooly labour, contracts entered into cannot be depended on, and purchases have frequently to be made in the open market at disadvantageous times. The quality supplied has also deteriorated. At the present time the Loco. Supdt. informed me Bengal coal cost at Jodhpur about Rs. 19 per ton, the increased cost being largely due to increased freight charges. He also said 1 ton of Welsh coal is *equivalent to about 1½ tons of Bengal coal* It would, I think, be worth while enquiring at what price complete cargoes of Welsh coal could be obtained at Karachi. At anything below Rs. 30 per ton it would probably answer to get sufficient coal for at least the western portion of the line. Coal.

30. I am inclined to think that too much money is being spent on Signalling and interlocking. As already noted a substantial economy should be possible by making the signals and plant in Jodhpur instead of importing them, but I think interlocking should only be indulged in when absolutely necessary, and this be as simple as possible. A simple form of interlocking between facing points and main signals is advisable at road side stations through which trains run at speed, but complicated systems of succession locks are often not only unnecessary but tend to delay work. At road side stations "isolation" is only necessary for the main line. Signalling

31 The sections of the line which are liable to be called on to carry the heaviest traffic and on which the most serious failures have occurred in the past are from Kuchaman Road via Jodhpur and Luni to Hyderabad. These are also the sections which will be most affected by the introduction of the Broad gauge, and so long as they can deal efficiently with all traffic offering, the very costly introduction of the Broad gauge cannot be considered necessary so far as the J. B Railway is concerned. I propose, therefore, to consider the present position and further requirements in these sections in some detail. Works for improving capacity.

The object to be arrived at is to start from Kuchaman Road as many full through loads as possible, to run these straight through without detention, and deliver them in Hyderabad so marshalled as to facilitate transhipment; and to leave the local traffic on each section to be dealt with by separate trains.

32 The first essential is a marshalling yard at Kuchaman Road. This can be conveniently placed alongside the B B & C. I. Ry. yard and should consist of 2 full length lines, and 3 or 4 short dead ends some 300 or 400 feet in length. This work is very urgent. Additional Siding Accommodation.

Between Kuchaman Road and Jodhpur all crossing stations except Jalsu and Umed, have now 3 lines. These two stations should be similarly extended but the work cannot be considered of great urgency. At Gotan and Pipar Road the loops are not full length and require to be lengthened.

A new crossing station is proposed at mile 29 between Borawar and Gachhipura where there is a section of 14 miles with a heavy grade. The cost of this is estimated at about Rs. 50,000/-. As the load is generally with the grade, this station is not so urgent as would appear at first sight but as it would undoubtedly increase the efficiency of the section it should, I think, be built in the next 2 years. Only absolute essentials should, however, be provided for, 2nd hand permanent-way be used, and the cost of signalling be kept as low as possible.

At Raikabagh where the Phalodi Branch joins the Main line 'line clear' cannot be given for Branch and Main line trains at the same time, and avoidable delays are incurred. To remedy this an estimate for remodelling the yard has been drawn up amounting to Rs. 50,000/-. I do not think this expenditure is justified at present. Apparently the desired result could be obtained by converting it into an ordinary Crossing station with one loop and the usual home and outer signals only.

At Jodhpur an extensive scheme of alterations is proposed and the drawing up of a complete plan should be continued. The new marshalling yard at Kuchaman Road should considerably reduce the shunting work to be done here and its actual effect should be awaited before big alterations are undertaken. It is proposed to move the Loco running yard, which is both too small and blocks extensions of the traffic yard. This must undoubtedly be done sooner or later but as the Loco yard meets immediate requirements fairly well, it might be left for the present. What is most required in the traffic yard is the lengthening of some of the loops and the addition of one or two dead ends for stocking purposes. I think it should be possible to provide space for these extensions at a small cost by altering the entrance into the loco. yard. These improvements are urgent and should be carried out as soon as possible. The local Goods Yard requires remodelling and enlarging. Any extension in this direction is blocked by the Carriage shed, overflow store yard, and shop workmen's tiffin shed, and these must, I think, be cleared out and the space thus obtained utilised to best advantage. There is, however, no very great urgency about this.

Between Jodhpur and Balotra all Crossing stations have now 3 lines. Sutlana Flag station is an important watering station. It is proposed to convert it into a crossing station to avoid delays; unless this can be done at a moderate expense. I am doubtful if it is justified at present.

Between Balotra and Barmer all crossing stations except Bhimarlai and Baniya Sanda Dhora have now 3 lines. This is a fairly easy section and there is no immediate urgency about extending these stations.

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Between Barmer and Mirpurkhas all stations have now 3 lines except Khadeen, Ramsar, Lilma, Munabao, Vasar Bah and Hasisar. There is no great urgency about these but a start should be made with Khadeen and Ramsar by next year. The loops at Chhor, Dhoronaro, Pithoro and Shadipalli are not of full length, and should be extended at once.

At Mirpurkhas the yard is very cramped and trains can only be admitted on to 2 lines The arrangement might I think be improved by altering the approaches to allow of Goods trains being admitted direct into the Goods yard and extending the accommodation as far as space permits

Between Mirpurkhas and Hyderabad a third line is required at Bulghai and Khesano These should be put in at once

At Hyderabad the accommodation is very limited Improvements have been deferred owing to the expected conversion to broad gauge. As this is now in the air,—I suggest the triangle be replaced by a turn-table which will give room for more siding accommodation and reception lines opposite the passenger platform Transhipment is at present confined to one platform, there is a short 2nd platform used only for bones and iron I think these two commodities could be dealt with elsewhere, and the platform extended and used as a second Tranship platform. It would then be possible to considerably expedite transhipment work by using each platform alternately. These alterations should be undertaken as early as possible.

33. Much of the J. B Railway lies through country of a more or less desert nature where no water can be obtained, or only of a quality which is unsuitable for locomotives or domestic purposes. This has always been a source of anxiety, and considerable expenditure has been incurred in opening up possible sources of supply and in carrying water by travelling tanks. Water supply

So far as I am aware no efficient alternative to the Steam Locomotive exists for hauling railway trains, except electric traction, which is out of the question on the J B. Railway. Various types of internal combustion engines have been experimented with and I took the opportunity lately of obtaining the views of Mr. Tritton of Messrs Rendel, Palmer and Tritton on the subject and understand no such engine has yet got beyond the experimental stage. It must be accepted then that watering stations capable of supplying on the average some 30,000 gallons of water per day are necessary about every 40 miles on the through line.

Between Kuchaman Road and Jodhpur the water supply is generally sufficient and of fairly good quality, but the following improvements are required.

Merta Road increased overhead storage and more pumping plant.

Pipar Road-water is brought by tanks. There is an apparently good well near the station in sandstone. It should be tested as regards quality and quantity, a good water supply at this station would be of great value.

At several stations on this length water for domestic purposes is brought by travelling tanks, an expensive and troublesome business. At certainly some of the stations so supplied there are indications that suitable water could be obtained on the spot without difficulty. This requires attention.

At Jodhpur water of excellent quality, and usually in any quantity, is obtained from the town supply. I understand, however, cases of shortness are not unknown.

The existence of an unquestionable supply here is vital to the Railway and unless this is absolutely assured the proposed broad gauge through line would have to take another route.

The real water trouble begins after leaving Jodhpur. At Luni Junction only brackish water can be obtained, and water is tanked in from Jodhpur. Water would be very valuable here and it would seem worth while to consider the possibility of a softening plant.

At Sutlana the overhead storage should be doubled. Between here and Balotra 47 miles there is no reliable watering station. A limited amount is available at Ajit but quality is poor. Water is found at Dundara and should be tested. A reliable emergency supply at one of these stations is much required.

At Balotra the supply is good but not sufficient for all emergencies. The well needs enlarging and either a new larger pipe line, or if possible, the steam pump should deliver direct through the pipe line to the station.

No water is obtained between Balotra and Barmer 60 miles and there appears to be no prospect of obtaining any. There is a watering station at Baitu supplied by tank wagons. The overhead supply here should be increased from 6,500 to about 15,000 gallons and a power pump provided.

At Barmer the supply is good, about 30,000 gallons per day, but requires increasing. Before sinking a new well borings should be made as suggested by Mr. Tipper. A new well has recently been sunk by villagers near the station. This should be tested, if water can be obtained there so much the better.

Between Barmer and Chhor, 110 miles, the only sources of supply are Jasai and Gadra Road, both are good but limited, and there remains a length of over 80 miles with no water and over which it has to be carried by tanks.

Mr. Tipper has suggested experimental borings at various places and the sooner these are taken in hand the better. At Gadra Road the wells, 350 feet deep, can probably be improved, as Mr. Tipper suggests.

From Chhor onward canal water is obtained but trouble is sometimes experienced during the period the canals are closed about two months.

At Dhoro Naro a well is being sunk in the river which it is hoped will give a good and permanent supply.

At Mirpurkhas a new additional well is required. The loco. yard here will probably require to be moved before long. The new well might advantageously be sunk to suit the new yard if the water there is found suitable.

Other works required

34. At Naranpura a new station building is required. At Degana an extension of the station building and improved waiting accommodation are required.

At Merta Road improved waiting accommodation is required. A *zenana* waiting room should be formed, by enclosing a corner of the 1st class waiting shed.

Barmer requires to be altered from an outside Engine station to a homing one, to enable the double crewing to be dispensed with, the engine shed needs enlarging and a number of new quarters are required.

New Projects.

35. The most promising of the new projects proposed appears to be that for a connection from Marwar Junction through Desuri to some point on the Oodypore line. Such a connection would not only open up a new through route from Sind and Marwar to the south but would serve some important places of pilgrimage and open up some rich forest country. As some of the country is apparently of a difficult nature a camplete survey should be carried out before any work is started.

F COUCHMAN.